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The investigation has continued in the use of information theory and in particular rate distortion theory to derive useable upper and lower bounds on the uxpected loss for the nonlinear filtering problem. A new design criterion has been derived which leads to effective designs of large systems when the entire state is not available for feedback control. Preliminary results have been obtained on the problem of absolute phase demodulation. New results which evaluate the information loss which results from use of the classical phase lock loop instead of the optimal demodulator, have been obtained and are being investigated.

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AFOSR-TR- 79-1152

# New Methods For Analysis of the Performance of Guidance and Control Systems

## ANNUAL INTERIM SCIENTIFIC REPORT

Grant AFOSR 76-3100
October 1, 1978 to September 30, 1979

Richard S. Bucy
Principal Investigator

### Personnel Supported

During the year the follwing people were supported: Graduate Student, Farmarz Ghovanlou; Secretaries, Celestine Holquin, Virginia Wright, Cathy Fekete, Lorna Freeman and Principal Investigator, R. S. Bucy.

### Research Summary

We continued to investigate the use of information theory and in particular rate distortion theory to derive useable upper and lower bounds on the expected loss for the nonlinear filtering problem. This has lead to an investigation of the constrained rate distortion function, where the variational problem which defines the rate distortion function is modified to include a realizability constraint, see (4).

In (6), we have derived a new design criterion which leads to effective designs of large systems when the entire state is not availiable for feedback control. This design minimizes the maximum time constant of the controlled system.

In the area of practical realization of nonlinear filters we have spent time in documenting the nonlinear filtering software we have developed for the Star, 7600,6600, the AP120B in (2). We have preliminary results on the problem of absolute phase demodulation see (7), and have developed extensive software to evaluate various absolute phase estimation techniques on the basis of cycle slip performance. New results which evaluate the information loss which results from use of the classical phase lock loop instead of the optimal demodulator, have been obtained and are being investigated.

## RESEARCH FORMALLY REPORTED

### Papers Appearing

(1) R. S. Bucy, Filtering and Information, Information Sciences, 18, 1979, 179-187.

(2) R. S. Bucy, F. Ghovanlou, A. J. Mallinckrodt, K. D. Senne, Software for Nonlinear Filtering, U. S. C. Aerospace Engineering Report #137, July 1979.

### Papers Submitted

(3) R. S. Bucy, S. J. Assev, D. A. Weissenberg, Estimation of Helicopter and Target Motion for the Advanced Attack Helicopter Fire Control System, submitted Automatica.

(4) R. S. Bucy, Distortion Rate Theory and Filtering, presented Proc. Info. II, Patras, Greece, 1979 and submitted, Information and Control.

(5) R. S. Bucy, K. D. Senne, Nonlinear Filtering Algorithms for Vector Processing Machines, to appear Mathematics and Computation, February 1980.

(6) R. S. Bucy, J. Velman, Minimax Control of Large Structures, invited paper, Proc. C.D.C. Fort Lauderdale, Florida, Dec. 1979.

(7) R. S. Bucy, J.M.F. Moura, A. J. Mallinkrodt, Absolute Phase Demodulation, abstract submitted to meeting, Microcomputers in Control, Ft. Lauderdale, Florida, Dec. 1979.